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## **CRUISE RESULTS**

### **NOAA VESSEL MILLER FREEMAN, CRUISE 93-12 1993 ALASKA FISHERIES SCIENCE CENTER WEST COAST UPPER CONTINENTAL SLOPE GROUNDFISH TRAWL SURVEY**

A bottom trawl survey of the groundfish resources of the upper continental slope was recently completed by the Resource Assessment and Conservation Engineering (RACE) Division of the Alaska Fisheries Science Center (AFSC). This report summarizes the preliminary results of the survey.

## **ITINERARY**

The survey was conducted aboard the NOAA research vessel Miller Freeman between October 12 and November 12, 1993. Exchange of scientific personnel occurred in Coos Bay, Oregon, during a mid-cruise break from October 26-27. The survey covered the upper continental slope waters 183-1,280 m (100-699 fm) deep in the central and southern portions of the International North Pacific Fisheries Commission (INPFC) Columbia area (43°00'N-45°30'N lat) and also included twelve stations on the northern edge of the INPFC Eureka area (42°47'N-43°00'N lat).

## **OBJECTIVES**

The annual groundfish slope surveys are designed to describe and monitor the abundance, geographic and bathymetric distribution, and biological characteristics of major groundfish resources inhabiting the upper continental slope of the U.S. Pacific coast. Previous surveys in this series were conducted in 1984, and annually between 1988, and 1992; each covering a different portion of the U.S. Pacific coast. The 1993 slope survey covered the central and southern portion of the INPFC Columbia area and the northern edge of the INPFC Eureka area. The northern portion of this area (44°09'N-45°20'N lat) was previously surveyed in 1984, 1988, and 1989. Stations in the Eureka area (south of 43°00'N lat) were previously surveyed in 1990. Stations between

43°00'N and 44°09'N lat were sampled once in 1984, but only at depths shallower than 500 fm.

The specific objectives for this cruise were to:

1. obtain biological data including sex, length, and length-weight for sablefish (Anoplopoma fimbria), Dover sole (Microstomus pacificus), shortspine thornyhead (Sebastolobus alascanus), longspine thornyhead (Sebastolobus altivelis), and arrowtooth flounder (Atheresthes stomias);
2. obtain age samples and maturity data from shortspine and longspine thornyhead, sablefish, Dover sole, and arrowtooth flounder for stock assessment analyses;
3. conduct a pilot study to establish the cross-shelf distribution of Pacific whiting (Merluccius productus) after the fall transition in the California Current system, identify the southward migratory path taken by whiting during their migration to the spawning grounds, and relate their migration to current flow at depth;
4. obtain stomach samples from shortspine thornyhead, longspine thornyhead, Dover sole, and deepsea sole (Embassichtys bathybius) as part of a long-term study of trophic relations of slope groundfishes;
5. describe the physical characteristics (temperature, current, and salinity profiles of the water column) of the slope habitat;
6. describe the fish community of the slope and how it varies with bathymetry;
7. obtain sablefish flesh firmness and color characteristic data from fish sacrificed for aging;
8. collect samples requested for special studies conducted by scientists at various fishery agencies and academic institutions; and
9. document the operating configuration of the footrope on the RACE west coast slope polyethylene Nor'eastern trawl using trawl-mounted video equipment and direct diving observations.

#### VESSEL AND GEAR

The research vessel Miller Freeman is a 65.5-m (215-ft) stern trawler equipped with modern trawling, oceanographic and hydrographic sampling systems and navigation and fishing electronics. The standard survey trawl used was the polyethylene high-opening Nor'eastern bottom trawl equipped with mud-sweep roller gear constructed of 203-mm (8-in) solid rubber disks

strung on 16-mm high tensile chain. Dimensions of this net are: 27.2-m (89-ft) headrope, 37.4-m (123-ft) footrope including the "flying wings", body constructed of 127-mm stretched mesh polyethylene netting, 89-mm stretched mesh codend, and a 32-mm stretched mesh codend liner. Each wing was attached to a 907-kg (2,000-lb), 1.8-m x 2.7-m (6-ft x 9-ft) steel V-door by three 55-m (180-ft) dandyline made of 16-mm galvanized steel cable. A SCANMAR<sup>1</sup> acoustic trawl mensuration system was used to obtain mean fishing dimensions of the Nor'eastern trawl and a Furuno wireless netsonde system was used to monitor bottom contact throughout each trawl haul. A Richard Brancker XL-200 submersible data logger was attached to the trawl and used in conjunction with a Trimble Global Positioning System (GPS) unit to gather data on the time, depth, water temperature and geodetic position during each trawl. These data were integrated with fishing dimensions of the net, producing a comprehensive set of data describing gear performance in space and time.

Water column temperature and salinity profiles were obtained using a Seabird Seacat SBE19 conductivity-temperature-depth (CTD) probe.

### **SURVEY DESIGN AND METHODS**

Sampling was conducted in a study area delineated by 24 cross-shelf tracklines situated 9 nm apart and containing 159 trawl stations. Eighty-four percent (133) of the station sites were occupied during previous slope survey cruises in 1984, and from 1988 to 1990. The remaining 26 station sites were selected with the same stratified random design used in other areas and years. The survey area was stratified by depth into six strata as follows: 183-365 m, 366-548 m, 549-731 m, 732-913 m, 914-1,096 m, and 1,097-1,279 m (100-199 fm, 200-299 fm, 300-399 fm, 400-499 fm, 500-599 fm, 600-699 fm). The number of potential sampling stations within each depth stratum were allocated proportional to the trackline length across each depth interval by assigning one station for every 13.0 km of linear trackline length (e.g., 3 stations would be allocated to a stratum with a trackline length of 30 km). Stations were randomly located along the appropriate trackline segment.

Stations were surveyed with the ship's fathometer and Global Positioning System (GPS) plotter before net deployment. Sampling at each station consisted of a controlled bottom trawl haul with a netsonde attached to the headrope to monitor headrope height

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<sup>1</sup>Reference to trade names or commercial firms does not constitute endorsement by the National Marine Fisheries Service, NOAA.

and bottom contact. A CTD cast was made at one station per stratum on every third trackline, starting with trackline 1, to obtain temperature and salinity profiles of the slope water column. After the trawl settled to the bottom, it was towed for 30 minutes at depths shallower than 732 m (400 fm) using scope ratios ranging from 1.8:1 to 2.5:1. Sixty-minute hauls were made at the deeper stations using scope ratios less than 1.8:1. Towing speed was approximately 3.7 km/hour (2 knots) at all stations and trawling operations occurred 24 hours per day. Trawl fishing dimensions were monitored at stations with depths less than 913 m (500 fm). Station data, including time, geodetic position, trawl dimensions, distance fished, salinity and temperature profiles, and catch and length information, were stored for later analysis using shipboard computer systems.

All catches were sorted to the lowest possible taxon, weighed, counted, and processed according to standard AFSC protocols. Samples of each fish species caught in every haul were measured for length composition. Otolith (age) samples were collected from the primary target groundfish species by sex-centimeter intervals in three depth strata (183-548 m, 549-913 m, and 914-1,279 m). Other biological data were collected from the major fish species encountered. Special study collections were stored in appropriate fixatives or frozen.

## RESULTS

Of the 24 proposed tracklines, 19 were completed during the survey. Out of 136 tows made, 125 stations were sampled successfully (Fig. 1). Four trawl sites had to be abandoned because the bottom was too rough. Data from nine tows were discounted because of poor net performance. One site was sampled two additional times to compare trawl performance and catch rates at different towing speeds. SCANMAR net mensuration data were obtained from 43 tows, submersible bathythermograph data from 92 tows, and GPS course and position data from 126 tows. Furuno netsonde height, vessel speed, vessel RPM, propeller pitch, and length of trawl warp out were recorded at 5-minute intervals for the last 111 tows. During the survey 58 CTD casts were completed.

A total of 113 fish species belonging to 51 families were identified in catches throughout the survey. In addition to the fish species, samples contained representatives from numerous orders of invertebrates. Table 1 summarizes the biological data collected from target and non-target species. Specimen ages will be determined by the AFSC Age and Growth Task using otolith collections.

Table 2 shows the dominant groundfish species and selected crab species caught by depth stratum and ranked in order of catch per unit effort (CPUE) expressed in kg/km trawled. Further analyses will be completed to describe distribution and to estimate biomass, population size, and age composition of these groundfish resources. Length-weight and length-maturity relationships will be derived to assist managers in assessing the status of important upper slope groundfish species.

The mean CPUE distributions for four primary target groundfish species and for grooved Tanner crab are shown in Fig. 2 by depth stratum. Longspine thornyheads and grooved Tanner crab had higher mean CPUE in the four deepest strata compared to the two shallow strata. Dover sole mean CPUE decreased with increasing depth. Mean CPUE's for sablefish and shortspine thornyhead varied with depth.

Plots of unweighted size composition of several target and non-target groundfish species are provided in Figs. 3-8, showing their size composition by depth stratum and by sex for the entire survey.

Additional research projects were accomplished during the west coast slope survey in cooperation with other divisions and agencies. A scientist from the Southwest Fisheries Science Center (SWFSC) Tiburon Laboratory collected 270 stomach samples during the first leg of the survey from four species to study the trophic relations of slope groundfishes. Ovary samples and maturity data were collected from 362 Pacific whiting for a study the SWFSC La Jolla Laboratory is conducting on whiting reproductive biology. Numerous twoline eelpouts (Bothrocara pusillum), Pacific grenadier (Coryphaenoides acrolepis), and giant grenadier (Albatrossia pectoralis) were collected for graduate students at the Moss Landing Marine Laboratory to do research on resource partitioning, age, and age validation using radiochemical techniques. The AFSC Pathobiology Task collected 70 pathology samples from seven different slope groundfish species to monitor fish health. White muscle tissue samples from seven commercially-important slope species were obtained for the Northwest Fisheries Science Center's Environmental Conservation Division to assess the contamination of fisheries resources.

The first day of the survey was spent observing the RACE west coast slope poly Nor'eastern trawl in Puget Sound by diving and using video equipment. Direct diver observation and video documentation of the operating configuration of the "mud-sweep" roller gear confirmed that it was tending bottom at towing speeds normally used during the slope survey. These observations were useful for evaluating the performance of the poly Nor'eastern as a standardized sampling tool for RACE slope surveys.

The last four days of the survey were used to do a pilot study to try to identify the southward migratory path taken by Pacific whiting (Merluccius productus) during their fall migration to spawning grounds. A series of cross-shelf hydroacoustic transects were done to locate and estimate the abundance of aggregations of Pacific whiting using echo integration techniques. Transects extended shoreward to a depth of 50 m and seaward to a distance of 50 km beyond the shelf continental break. Two midwater tows were made to verify the echo sign and

to provide samples of Pacific whiting for biological data. The ship's Acoustic Doppler Current Profiler was used to gather data on ocean currents and CTD data were collected to identify the temperature and salinity properties of water masses.

Gerald Gunnari, a self-employed fisherman from Charleston, Oregon, and a representative from the west coast commercial fishing industry, participated in the first leg of the survey. He was able to get a firsthand look at sampling procedures, data collection, and trawl performance. Numerous tows during the first leg of the survey showed decreasing net height, net width, or both. Many such tows also came up filled with mud and benthic invertebrates indicating that the net may not have been fishing effectively on a soft bottom. These observations prompted Gerald to voice concerns over gear performance and on the impact of using such data for survey estimates of abundance and in the management process. In response to these concerns, the RACE Division has assigned working groups to evaluate net design and performance, towing protocols, and the way data from the slope surveys are analyzed. A series of science and industry workshops scheduled to take place in several cities along the west coast from January-April 1994 will also provide an open forum in which to discuss concerns that fishermen may have about west coast groundfish surveys.



**SCIENTIFIC PERSONNEL**Leg I (October 12-26)

Robert Lauth	Chief Scientist
Claire Armistead	AFSC
Steve de Blois	AFSC
Gerald Gunnari	FMA
Nick Hodges	AFSC
Mike MacEwan	AFSC
Debra McFee	AFSC
Gary Mundell	AFSC
Jean Rogers	SWFSC
Jim Smart	AFSC
Ken Weinberg	AFSC
Mark Wilkins	AFSC

Leg II (October 27-November 12)

Robert Lauth	Chief Scientist
Dan Decker	AFSC
Bill Flerx	AFSC
Larry Haaga	AFSC
Robin Harrison	AFSC
Allen Harvison	AFSC
David King	AFSC
Russell Svec	MFM
Mark Wilkins	AFSC
Mark Zimmermann	AFSC

AFSC = Alaska Fisheries Science Center, Seattle, Washington  
 SWFSC = Southwest Fisheries Science Center, Tiburon Laboratory,  
 Tiburon, California  
 MFM = Makah Fisheries Management, Neah Bay, Washington  
 FMA = Fisherman's Marketing Association, Charleston, Oregon

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